Sn. 15

PRELIMINARY
INSTRUCTION MANUAL

MODEL 191
20 MHz PULSE/FUNCTION GENERATOR

WAVETEK
SAN DIEGO

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20 MHz PULSE/FUNCTION GENERATOR

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WAVETEK®
SAN DIEGO
9045 Balboa Ave., San Diego, CA 92123
P. O. Box 651, San Diego, Calif. 92112
Tel 714/279-2200 TWX 910-335-2007

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CONTENTS

SECTION 1 GENERAL DESCRIPTION

1.1 THE MODEL 191 1-1
1.2 SPECIFICATIONS 1-1
1.2.1 Main Generator 1-1
1.2.2 Pulse Generator 1-2
1.2.3 Frequency Precision 1-2
1.2.4 Amplitude Precision 1-2
1.2.5 Waveform Characteristics 1-2
1.2.6 General 1-3

SECTION 2 INITIAL PREPARATION

2.1 MECHANICAL INSTALLATION 2-1
2.2 ELECTRICAL INSTALLATION 2-1
2.2.1 Power Connection 2-1
2.2.2 Signal Connections 2-1
2.3 ELECTRICAL ACCEPTANCE CHECK 2-1

SECTION 3 OPERATION

3.1 CONTROLS AND CONNECTORS 3-1
3.2 OPERATION 3-5
3.2.1 Signal Termination 3-5
3.2.2 Manual Function Generator Operation 3-5
3.2.3 Voltage Controlled Function Generator Operation 3-6
3.2.4 Waveforms 3-6
3.2.5 Pulse Generator Operation 3-6
3.2.6 Burst Generator Operation 3-7

SAFETY

This instrument is wired for earth grounding via the facility power wiring. Do no bypass earth grounding with two wire extension cords, plug adapters, etc.

BEFORE PLUGGING IN the instrument, comply with installation instructions.

MAINTENANCE may require power on with the instrument covers removed. This should be done only by qualified personnel aware of the electrical hazards.

The instrument power receptical is connected to the instrument safety earth terminal with a green/yellow wire. Do not alter this connection. (Reference: ⏚ or ⚠ stamped inside the rear panel near the safety earth terminal.)

WARNING notes call attention to possible injury or death hazards in subsequent operations.

CAUTION notes call attention to possible equipment damage in subsequent operations.

SECTION 1
GENERAL DESCRIPTION

1.1 THE MODEL 191

Wavetek Model 191, a 20 MHz Pulse/Function Generator, is a precision source of sine, triangle, square and pulse waveforms plus dc voltage. All waveforms are variable from 0.002 Hz to 20 MHz and can be externally modulated. Outputs can be continuous or can be triggered or gated by external signal or front panel switch. Variable width and delay, single or double pulses can be inverted or normal. Pulse and square wave fixed baseline selectable may be varied from fixed baseline to 15 Vp-p (7.5 Vp-p into 50Ω). An internal burst generator gates main generator and operates in continuous, triggered and gated modes. Amplitude of the waveforms is variable from 30 Vp-p (15 Vp-p into 50Ω) down to 1.5 mVp-p. DC reference of the waveform can be offset positively or negatively. Maximum 150 mA peak current can be continuously varied over an 80 dB range. A sync output provides a TTL level into 50Ω.

1.2 SPECIFICATIONS

1.2.1 Main Generator

Waveforms
Selectable sine ∿ , triangle ∧ , square ⊓ , pulses, double pulses and dc.

Symmetry
With SYM on, waveforms may be varied to produce sawtooth ◿ and variable duty cycle pulse ⊓ from 1:19 to 19:1.

NOTE

SYMMETRY and VERNIER controls affect frequency calibration. Maximum possible asymmetry is a function of frequency setting.

When SYM control is used, indicated frequency is divided by approximately 10.

Operational Modes

Function
Continuous: Generator oscillates continuously at selected frequency.

Triggered: Generator is quiescent until triggered by external signal or manual trigger, then generates one cycle at selected frequency.

Gated: As triggered mode, except generator oscillates for the duration of gate signal plus time to complete the last cycle.

Burst
Internal burst generator gates main generator and operates in continuous, triggered and gated modes.

Burst Rate: 1 Hz to 5M in 7 ranges.

Burst Width: 20 ns to 100 ms in 7 ranges.

Frequency Range
0.002 Hz to 20 MHz in 9 overlapping decade ranges with approximately 1% of full scale vernier.

Function Output
∿ , ∧ , ⊓ and pulse selectable and variable to 30 Vp-p (15 Vp-p into 50Ω). Pulse and ⊓ fixed baseline selectable (⎍ , ⎍ , ⎍) and can be inverted. ⊔ , ⊔ can be varied from fixed baseline to 15 Vp-p (7.5 Vp-p into 50Ω). All waveforms and dc may be attenuated in 10 db steps to 70 dB with 10 dB vernier for overall attenuation of 80 dB. 50Ω source impedance.

DC Output and DC Offset
Selectable thru function output BNC. Controlled by front panel control with separate on-off switch. Adjustable between ±15 Vdc (±7.5 Vdc into 50Ω) with signal peak plus offset limit to ±15 Vdc (±7.5 Vdc into 50Ω). DC offset and output waveform attenuated proportionately by 0 to 70 dB output attenuator.

Sync Output
A TTL level square wave synchronized to the main generator. Duty cycle varies with symmetry control. 50Ω source impedance.

Pulse/Square Output
A TTL level pulse or square wave whose transitions are simultaneous with function output (square and pulse only). 50Ω source impedance.

VCG—Voltage Controlled Generator
Up to 1000:1 frequency change with external 0 to ±5V signal. Upper frequency limited to maximum of selected range.

Slew Rate: 2% of range per μs.

Linearity: ±0.5% thru ×100K range. ±5% on ×1M and ×10M range.

Impedance: 5 kΩ.

Trigger (and Gate) Input
Input Range: 1 Vp-p to ±10V.

Trigger Level Adj: −5V to +5V.

Impedance: 10 kΩ.

Pulse Width: 25 ns minimum.

Repetition Rate:

Input	Max Rep Rate
±1V	1 MHz
±2.5V	10 MHz

1.2.2 Pulse Generator

Pulse Modes
Normal Pulse: Adjustable width pulse in phase with pulse sync output. Repetition rate is set by frequency of main generator.

Pulse Delay: Pulse delayed with respect to pulse sync output. Pulse delay and pulse width adjustable.

Double Pulse: Two pulses for every period. Time between pulses and pulse width adjustable.

Sync Delay: Pulse sync output delayed with respect to pulse output. Delay is adjustable.

NOTE

Function modes of Continuous, Triggered and Gated, but not Burst, also applicable.

Pulse Period Range
50 ns to 500 sec in 9 decade ranges.

Pulse Width
20 ns to 100 ms in 7 ranges.

Pulse or Sync Delay
0 ns to 100 ms in 7 ranges.

Duty Cycle
Up to: 75% for pulse widths >100 ns 50% for pulse widths of 20 to 100 ns.

Pulse/Burst Sync Output
A TTL level pulse when terminated with 50Ω. Reference for pulses and bursts at function output BNC and TTL pulse BNC.
In pulse function mode (normal pulse) and burst mode, sync output is coincident with leading edge of pulse/burst output and has width of at least 3% of selected pulse/burst width.

NOTE

Also see Pulse Modes.

1.2.3 Frequency Precision

Dial Accuracy
±3% of full scale from ×0.1 Hz to ×1 MHz.
±5% of full scale on ×10M range.

1.2.4 Amplitude Precision

Amplitude Change with Frequency
Sine variation with frequency:
< ±0.2 dB on all ranges thru ×100K.
< ±0.5 dB on ×1M range.
< ±1.0 dB on ×10M range.

Step Attenuator Accuracy
±0.3 dB with 10, 20 and 40 dB.
±0.6 dB with 30, 50 and 60 dB.
±0.9 dB with 70 dB setting.

1.2.5 Waveform Characteristics

Sine Distortion
<0.5% on ×100, ×1K and ×10K.
<1.0% on ×0.1 to ×100 ranges.

All harmonics 30 dB below fundamental on ×100K, ×1M range, and 25 dB below on ×10M range.

Square Wave and Pulse
Rise/Fall Time at Function Output BNC:
<15 ns (10% to 90%).

Total Aberrations:
±5% of full amplitude.

Time Symmetry
Square wave variation from 0.1 to 2 on dial:
< ±1% to 200 kHz.
< ±10% to 20 MHz.

Triangle Linearity
>99% for 0.002 Hz to 200 kHz.

1.2.6 General

Stability
Main generator amplitude, frequency and dc offset. After 30 minute warm-up:
±0.05% for 10 minutes.
±0.25% for 24 hours.

Environmental
Specifications apply at 25°C ±5°. Instrument operates 0°C to +50°.

Dimensions
28.6 cm (11¼ in.) wide; 13.3 cm (5¼ in.) high; 28.6 cm (11¼ in.) deep.

Weight
4.6 kg (10 lb) net; 6.4 kg (14 lb) shipping.

Power
100/120/220/240V (+5%, −10%), 48 Hz to 440 Hz, ≤50 VA.

NOTE

All specifications apply from 0.1 to 2.0 on frequency dial, when FUNC OUT amplitude is maximum and 50Ω terminated, and with SYM control OFF.

SECTION 2
INITIAL PREPARATION

2.1 MECHANICAL INSTALLATION

After unpacking the instrument, visually inspect all external parts for possible damage to connectors, surface areas, etc. If damage is discovered, file a claim with the carrier who transported the unit. The shipping container and packing material should be saved in case reshipment is required.

2.2 ELECTRICAL INSTALLATION

2.2.1 Power Connection

NOTE

Unless otherwise specified at the time of purchase, this instrument was shipped from the factory with the power transformer connected for operation on a 120 Vac line supply and with a ½ amp fuse.

Conversion to other input voltages requires a change in rear panel fuse holder voltage card position and fuse (figure 2-1) according to the following procedure.

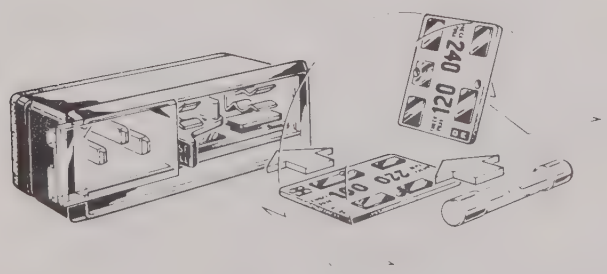


Figure 2-1. Voltage Selector and Fuse

1. Disconnect the power cord at the instrument, open fuse holder cover door and rotate fuse-pull to left to remove the fuse.

2. Remove the small printed circuit board and select operating voltage by orienting the printed circuit board to position the desired voltage to the top left side. Push the board firmly into its module slot.

3. Rotate the fuse-pull back into the normal position and insert the correct fuse into the fuse holder. Close the cover door.

4. Connect the ac line cord to the mating connector at the rear of the unit and the power source.

Card Position	Input Vac	Fuse
100	90 to 105	3/4 amp
120	108 to 126	3/4 amp
220	198 to 231	3/8 amp
240	216 to 252	3/8 amp

2.2.2 Signal Connections

Use RG58U 50Ω coaxial cables equipped with BNC connectors to distribute signals when connecting this instrument to associated equipment.

2.3 ELECTRICAL ACCEPTANCE CHECKOUT

This checkout procedure verifies the generator operation. If a malfunction is found, refer to the Warranty in the front of this manual. A dual trace, 150 MHz bandwidth oscilloscope with X 10 time base magnification, a 50Ω load, a coaxial tee and three 50Ω cables are required to perform this checkout.

Set up as in figure 2-2 and preset the generator front panel controls as follows. Perform the steps in table 2-1.

Control	Position
Dial	1.0
FREQ MULT	1K
VERNIER/SYM	FREQ CAL (cw)

SYM ..... Off(extended)
MODE ..... CONT (FUNC)
TRIG LEVEL ..... 10 o'clock
FUNCTION ..... ∿
DC OFFSET (On/Off) ..... OFF(Extended)
DC OFFSET (Variable Control) ..... ccw
OUTPUT ATTEN 40, 20, 10 ..... All Extended
AMPLITUDE ..... MAX (cw)
PULSE DELAY (Range) ..... 10 μs to 100 μs
PULSE DELAY (Vernier) ..... ccw
PULSE (Pushbuttons) ..... NORM (Pressed)
PULSE WIDTH (Range) ..... 10 μs to 100 μs
PULSE WIDTH (Vernier) ..... cw
PULSE/SQUARE OUTPUT ..... ⎍
INV ..... Normal (Extended)
POWER ..... ON

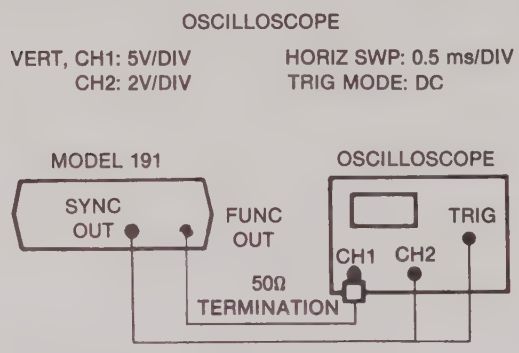


Figure 2-2. Initial Checkout Setup

Table 2-1. Checkout Procedure

Step	Control	Position/Operation	Observation
1	Oscilloscope	Trig level and slope, both positive.	CH2: Square wave that begins on positive going edge. CH1: 15 Vp-p square wave.
2	Dial and VERNIER/SYM	Rotate dial full cw, vernier full ccw. Then the opposite. Return dial to 1.0, vernier to CAL.	CH2: Square wave remains in sync for all dial positions. Range is less than 2 Hz to 2000 Hz (1000:1).
3	FREQ MULT	Rotate to all positions. Return to 1K position.	Frequency is 1 × each range position.
4	AMPLITUDE	Set to 6 Vp-p on scope.	CH1: Amplitude decreases to approximately 6 Vp-p.
5	DC OFFSET	Depress DC OFFSET switch, then rotate DC OFFSET Control CW. (Extended DC OFFSET upon completion.)	Full CCW gives negative offset. Clipping occurs when the offset plus waveform peak amplitude exceeds approximately ±7.5V into 50Ω. Initially the negative peak is clipped, but as the DC offset is rotated cw the clipping of the negative peak disappears and eventually the positive peak begins to clip.
6	AMPLITUDE	Rotate cw.	Waveform returns to 15 Vp-p.
7	OUTPUT ATTN 10, 20, 40	Depress buttons in various combinations. Then release all buttons.	Output level varies from 15 Vp-p (0 dB) to 4.7 mV (70 dB).
8	FUNCTION	Rotate ccw. Select DC ∿ , ⩘ , ⎍ . Reset to ∿ .	Observe 0 Vdc level; ∿ , ⩘ and ⎍ are 15 Vp-p. Note phase relationships; ⎍ in phase with ∿ and ⩘ .

Table 2-1. Checkout Procedure (Cont)

Step	Control	Position/Operation	Observation
9	SYM, VERNIER/SYM.	Depress SYM switch and rotate VERNIER/SYM control ccw. Extend SYM, return VERNIER/SYM to CAL.	Frequency decreases to approximately 1 kHz. CCW of the 12 o'clock position gives 1:19; CW gives 19:1 (a skewed sinewave and variable duty cycle pulses can be observed for ∿ and ⊓ .)
10	MODE and FUNCTION	Select GATE. Select ∿ , ∿ , ⊓ . Return to ∿ .	A dc level near zero volts (except ⊓ function; quiescent level is at negative peak value).
11	MANUAL TRIGGER	Press, hold and release. Return to FUNC CONT.	A burst of ∿ for the period the MAN TRIG is depressed.

Set MODE to CONT (FUNC). (All other controls will be as for initial setup.) Setup oscilloscope and Model 191 as shown in figure 2-3. The following steps demonstrate pulse from selectable baselines and width and delay ranges.

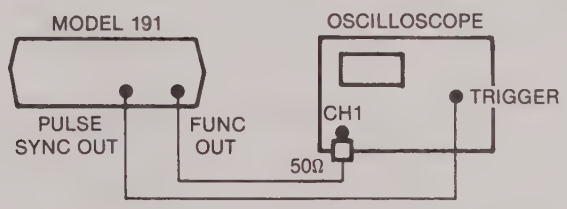


Figure 2-3. Pulse Checkout Setup

12	FUNCTION	PULSE	Pulse
13	AMPLITUDE	Vary, then return cw.	Upper and lower levels vary from 0.5V to 15 Vp-p.
14	PULSE/SQUARE OUTPUT	Depress INV, then release INV.	180° phase inversion of pulse relative to PULSE SYNC OUT.
15		Depress ⎍ .	Positive offset pulse +7.5V.
16	AMPLITUDE	Vary, then return to full cw.	Upper level varies, lower level remains fixed. Full variation from 0.5V to +7.5 Vp-p.
17	PULSE/SQUARE OUTPUT	Depress ⎍ .	Negative offset pulse −7.5 Vp-p.
18	AMPLITUDE	Vary, then return to full cw. Return to ⎍ .	Low level varies, upper level remains fixed. Full variation from 0.5V to −7.5 Vp-p.

The next 2 steps demonstrate pulse width range of 20 ns to 100 ms.

Table 2-1. Checkout Procedure (Cont)

Step	Control	Position/Operation	Observation
19	Dial FREQ MULT PULSE WIDTH Scope PULSE WIDTH VERNIER	2.0 1 10 ms - 100 ms. 20 ms Sweep Time. Rotate ccw, cw.	10 ms to more than 100 ms pulse width.
20	Dial FREQ MULT PULSE WIDTH Scope PULSE WIDTH VERNIER	.2 10M 20 ns - 100 ns. 0.2 μs Sweep Time. Rotate ccw, cw.	20 to 100 ns pulse width.
	The next steps demonstrate pulse delay range of 0 to 100 ms.		
21	PULSE PULSE DELAY Scope PULSE DELAY VERNIER	Depress PULSE DLY. 0 ns - 100 ns. 0.2 μs Sweep Time. Rotate ccw, cw.	0 to more than 100 ns pulse delay.
22	Dial FREQ MULT PULSE WIDTH PULSE DELAY Scope PULSE DELAY VERNIER	2.0 1 10 ms - 100 ms. 10 ms - 100 ms. 20 ms Sweep Time. Rotate ccw, cw.	Observe a more than 100 ms PULSE DELAY (NOTE: PULSE DELAY decreases to less than 10 ms). 10 ns to more than 100 ms pulse delay.
	The next step demonstrates burst control.		
23	MODE FUNCTION Dial FREQ MULT BURST RATE BURST RATE VERNIER BURST WIDTH Scope BURST WIDTH VERNIER	CONT BURST ∿ 2.0 10K 100 - 1K 12 o'clock. 100 μ1s - 1 ms. 0.5 ms Sweep Time. Vary cw and ccw.	Number of cycles in burst increases (cw) and decreases (ccw).

To demonstrate external triggering, set up trigger source as shown in figure 2-4. Set trigger source for 200 Hz triangle 10 Vp-p signal. Set scope for one cycle of triggering waveform; display both channels. Setup Model 191 controls for initial setup except set MODE to GATE. The following steps demonstrate burst, trigger level control and trigger.

Table 2-1. Checkout Procedure (Cont)

Step	Control	Position/Operation	Observation
24	TRIG LEVEL	Rotate throughout its range. Return to 10 o'clock.	The number of waveform cycles in each gated "burst" varies with the trigger level. Notice relationships between Channels 1 and 2 waveforms as the TRIGGER LEVEL is rotated.
25	MODE	Select TRIG.	A single triggered ∿ recurring at the 200 Hz trigger rate.

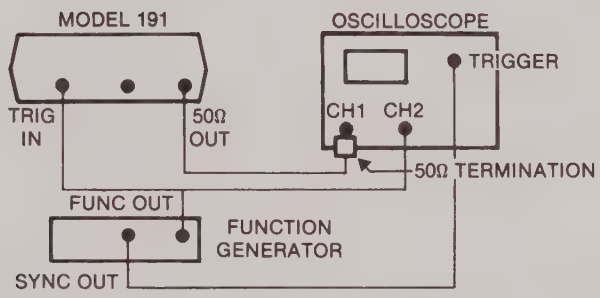


Figure 2-4. Trigger Checkout Setup

SECTION 3
OPERATIONS

3.1 CONTROLS AND CONNECTORS

The generator front panel controls and connectors are shown in figure 3-1 and keyed to the following descriptions.

1 **Frequency Dial** — Settings under the dial index mark summed with VCG IN **19** and multiplied by FREQ MULT **17** determine the output signal frequency.

2 **PULSE DELAY/BURST RATE Selector** — Outer coax knob selects one of seven ranges. An inner coax knob, VERNIER, controls the delay or rate within each range.

In pulse function, these controls set the delay of the pulse at FUNC OUT **10** and PULSE/SQUARE OUT **12** (PULSE DLY **4** depressed), or the delay of the pulse at PULSE SYNC OUT **16** relative to FUNCTION OUT **10** and PULSE/SQUARE OUT **12** (SYNC DLY **4** depressed). Pulse delay and sync delay are variable between 0ns to 100 ms.

In burst modes, the BURST RATE and VERNIER controls set the burst repetition rate. Repetition varies between 1 Hz and 5 MHz.

3 **SYM Pushbutton** — When depressed, allows the waveform symmetry to be varied from 19:1 to 1:19 by the VERNIER/SYM control **17**; (as a result the generator frequency is divided by 10).

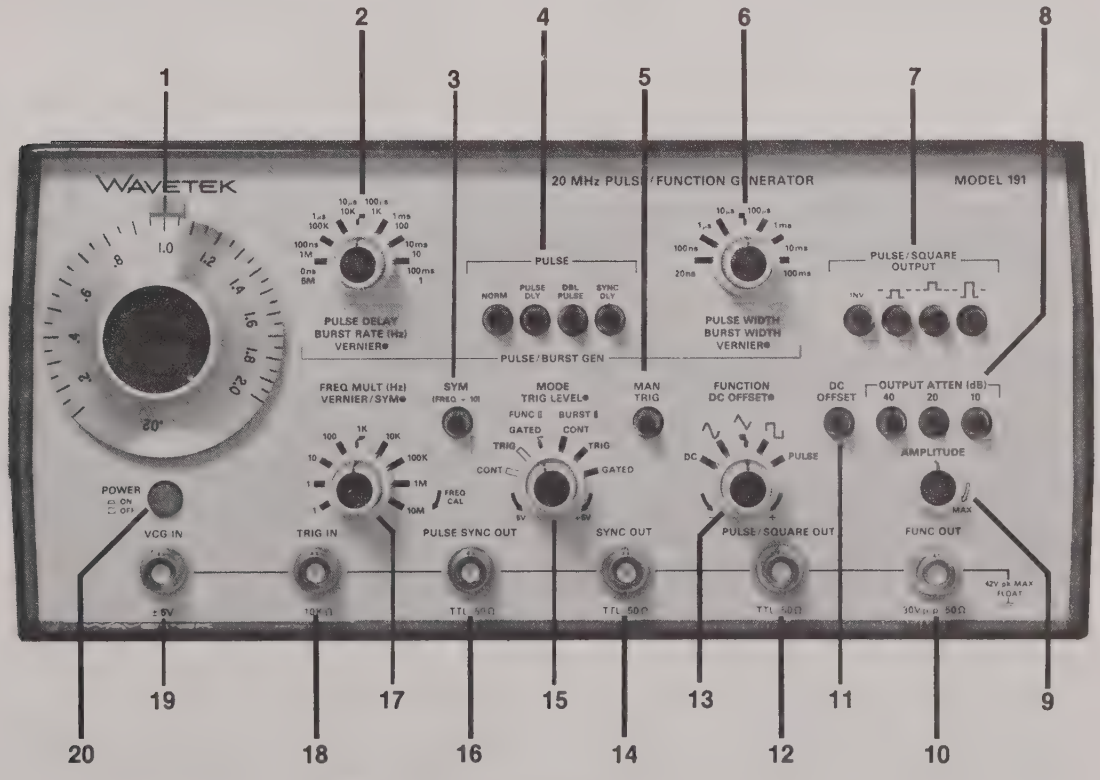


Figure 3-1. Controls and Connectors

When extended, the switch allows the generator to produce normal (50% duty cycle) waveforms.

4 **PULSE Pushbuttons** — Four mutually exclusive switches that select either normal pulse, pulse delay, double pulse or sync delay when FUNCTION switch **13** is set to PULSE.

NORM — Selects a pulse at FUNC OUT **10** and PULSE/SQUARE OUT **12** in phase with PULSE SYNC OUT **16**. PULSE WIDTH **6** controls the width or the normal pulse, and the frequency dial **1** and FREQ MULT **17** set the pulse repetition rate.

PULSE DLY — Selects a pulse that is delayed relative to PULSE SYNC OUT **16.** PULSE DELAY **2** controls the delay of the pulse, the frequency dial**1** and FREQ MULT **17** control pulse repetition rate, and PULSE WIDTH **6** sets the width of each pulse.

DBL PULSE — Selects two pulses for each pulse period. In double pulse, PULSE DELAY **2** sets the start of the second pulse relative to the first. The frequency dial **1** and FREQ MULT **17** control the repetition rate for each pulse pair. PULSE WIDTH **6** controls pulse width of both pulses.

SYNC DLY — Selects a variable delay sync pulse at the PULSE SYNC OUT **16** relative to FUNC OUT **10** and PULSE/SQUARE OUT **12**. PULSE DELAY **2** controls the delay of the pulse sync. Frequency dial **1** and FREQ MULT **17** set repetition rate of the pulse.

5 **MAN TRIG Pushbutton** — Triggers or gates the output signals when generator mode is TRIG or GATED **15**. In function trigger mode, one waveform cycle is output when the button is pushed; in burst trigger mode, one burst. In function gated mode, waveform cycles are continuously output as long as the button is held in; in burst gated mode, burst are continuously output.

6 **PULSE WIDTH/BURST WIDTH** — Outer coax knob selects one of seven decade ranges. An inner coax knob, VERNIER, controls the width within each range. In pulse function PULSE WIDTH sets the width of the pulse at FUNC OUT **10** and PULSE/SQUARE OUT **12**.

In burst modes, BURST WIDTH sets the burst duration at FUNC OUT **10** and, in ⊓ function only, at PULSE/SQUARE OUT **12**.

7 **PULSE/SQUARE OUTPUT** — Selects the pulse amplitude symmetry relative to the baseline (ref: figure 3-2). With DC OFFSET **11** off, the baseline is 0 volts. With DC OFFSET on, the baseline is varied by the DC OFFSET control **13**.

⊓ selects a pulse that maintains amplitude symmetry about its centerline. AMPLITUDE **9** adjust the peak-to-peak level of the pulse.

⊓ selects the positive pulse. AMPLITUDE **9** adjust the positive peak while the negative peak remains a fixed baseline.

⊓ selects the negative pulse. AMPLITUDE control **9** adjusts the negative peak while the positive peak remains a fixed baseline.

INV pushbutton — selects normal or inverted pulse output. An inverted pulse is a reversal of the active and inactive levels of the pulse. The net result for a square pulse inversion would be a 180° phase shift with respect to the PULSE SYNC OUT **16**.

8 **OUTPUT ATTEN Pushbuttons** — Select the attenuation range of the FUNC OUT **10** signal. The AMPLITUDE control **9** allows continuous waveform level variations within each attenuator range. Each of the three buttons may be used individually for 40, 20 or 10 dB steps of attenuation, or pressed in combinations for up to 70 dB of attenuation. The attenuator attenuates both the waveform and dc offset.

9 **AMPLITUDE Control** — Continuously varies the waveform amplitude within each OUTPUT ATTEN **8** range. CCW rotation reduces waveform amplitudes at FUNC OUT **10** by greater than 10 dB. DC and dc offset voltages are not affected by this control.

10 **FUNC OUT Connector** — This BNC is the waveform (or dc) output of the generator. Maximum output is 30 Vp-p (15 Vp-p into 50Ω). Source impedance is 50Ω.

11 **DC OFFSET Pushbutton** — Depressed button activates the dc offset (ref: **13**). Extended button ensures zero dc offset.

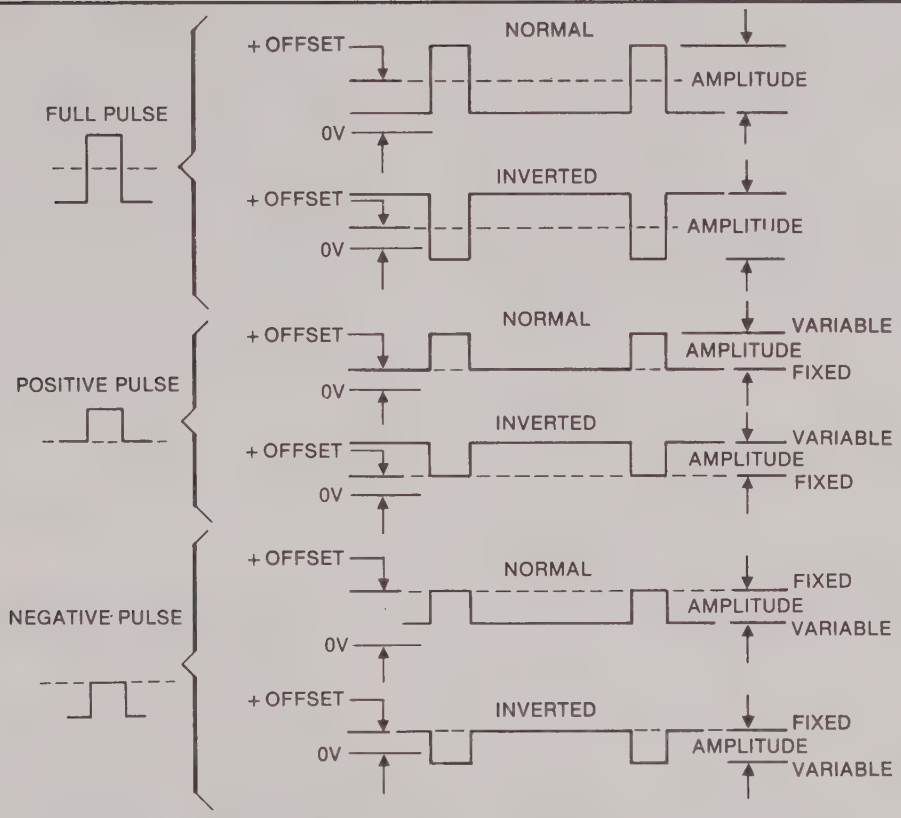


Figure 3-2. PULSE/SQUARE OUTPUT Amplitude/Offset Relationship

12 PULSE/SQUARE OUT Connector — BNC output is a TTL level into 50Ω. Output is simultaneous and exclusive with FUNC OUT **10** square wave or pulse output. Source impedance is 50Ω.

13 FUNCTION Selector — Outer coaxial knob selects one of four waveforms (sine, triangle, square, pulse) or dc.

DC OFFSET Control — Inner coaxial knob offsets the FUNC OUT **10** output waveform vertically from its normal position and when FUNCTION (outer coaxial knob **13**) is in the DC position, controls polarity and voltage of dc output. DC output range is 0 ±10 Vdc (±5 Vdc into 50Ω). DC OFFSET switch **11** must be depressed to enable this DC OFFSET Control. Extending the DC OFFSET switch ensures zero volt offset. DC offset and waveform are attenuated by the OUTPUT ATTEN control **8** but dc offset is not attenuated by the AMPLITUDE control **9**. Waveform peak voltage plus dc offset is limited to ±15 Vdc (±7.5 Vdc into 50Ω). See figure 3-3.

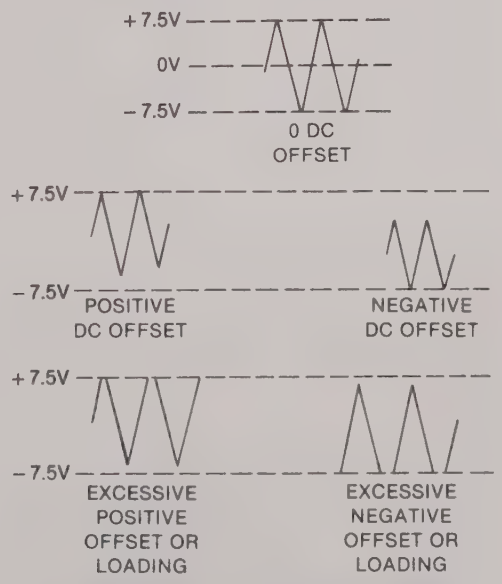


Figure 3-3. DC OFFSET Control

14 **SYNC OUT Connector** — The sync signal from this BNC is a TTL level into 50Ω synchronous with FUNC OUT **10** signal. Duty cycle varies with waveform symmetry. Source impedance is 50Ω.

15 **MODE Control** — This outer coax knob selects one of the six operating modes. Three of the modes are burst generator modes (switch detents are solid black) and three are function generator modes (switch detents are white). Figure 3-8 illustrates the output in each of these modes.

FUNC Modes

CONT — Continuous output at FUNC OUT **10** and SYNC OUT **14** connectors.

TRIG — A dc level output at FUNC OUT **10** until the generator is triggered by the MAN TRIG **5** or with a signal at the TRIG IN connector **18**. When triggered the generator output is one cycle of waveform followed by a dc level.

GATED — As for TRIG except the output is continuous for the duration of the manual or external trigger signal. The last waveform cycle started is always completed.

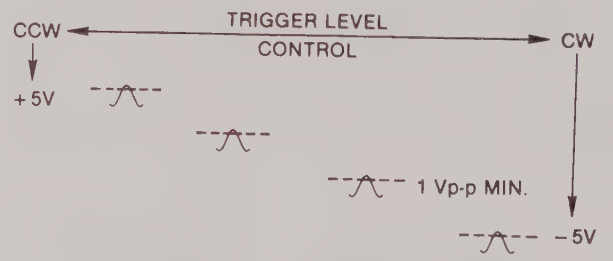
BURST Modes

CONT — Continuous burst is a series of bursts from FUNC OUT **10** at a continuous repetition rate. BURST RATE **2** sets the repetition rate of each burst. Frequency dial **1** and FREQ MULT **17** determine the frequency of waveform cycles in each burst. BURST WIDTH **6** sets the number of cycles within each burst.

TRIG — A trigger (manual **5** or external **18**) initiates a burst of cycles from FUNC OUT **10**. The trigger rate determines the burst repetition rate. Frequency dial **1** and FREQ MULT **17** determine the frequency of waveform cycles in each burst. BURST WIDTH **6** sets the number of cycles within each burst.

GATED — When triggered (external **18** or manual **5**), FUNC OUT **10** produces a series of bursts for the active period of the trigger signal. Frequency dial **1** and FREQ MULT **17** sets the frequency of the cycles in the burst. BURST RATE **2** controls the repetition rate between bursts and BURST WIDTH **6** sets the number of cycles within each burst.

TRIG LEVEL Control — This inner coax knob is a continuously variable adjustment of the trigger circuitry firing point. When full ccw, a positive going signal at approximately +5V is required for triggering (see figure 3-4). In the full cw position, a positive going signal at approximately −5V or more positive voltage is required for triggering. In the GATED modes, the generator will run continuously when the control is cw of 12 o'clock.



Trigger signal must be a positive going signal exceeding the TRIGGER LEVEL setting.

Figure 3-4. Minimum Trigger Signal

16 **PULSE SYNC OUT Connector** — With normal pulse function or burst mode selected, this BNC output supplies a TTL level pulse that is coincident with the leading edge of the pulse or burst at FUNC OUT **10**. Sync pulse width is greater than 3% of the selected pulse/burst width. Source impedance is 50Ω.

In sync delay (ref: **4**), PULSE DELAY **2** controls the delay of PULSE SYNC OUT relative to FUNC OUT **10** and PULSE/SQUARE OUT **12**.

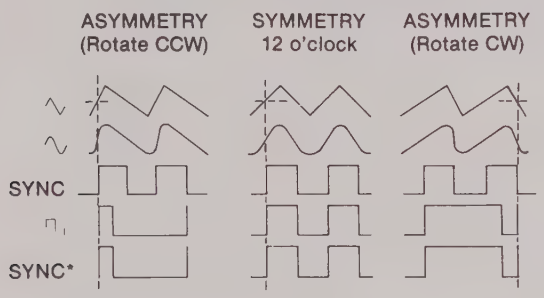
NOTE

PULSE SYNC OUT is the correct sync signal for the pulse waveform and the burst mode.

17 **FREQ MULT Control** — Outer coax knob selects one of nine frequency multipliers for dial **1** setting.

VERNIER/SYM Control — When the SYM switch **3** is off (extended) this inner coax knob is a fine adjustment of the frequency dial **1** setting. CCW rotation decreases the frequency by approximately 1%. When in cw position (FREQ CAL), the settings on the dial will be accurate. When SYM switch is on (depressed) this control

varies the symmetry of the waveforms (normally 50% duty cycle). Symmetry range is 19:1 to 1:19 (half cycle to half cycle ratio). When SYM is used, the main generator frequency is divided by 10. Extending SYM switch ensures 1:1 (50%) symmetry. See figure 3-5.



* SYNC DUTY CYCLE VARIES SAME AS FUNC OUT SIGNAL WHEN SQUARE FUNCTION (⊓) IS SELECTED.

Figure 3-5. Effect of Symmetry Control

18 TRIG IN Connector — BNC receives the external trigger and gate signals. These signals are applied to the trigger and gate circuit when the MODE switch **15** is in the TRIG or GATED positions. Refer to Section 1 Trigger (and Gate) Input specifications, for trigger signal requirements. The TRIG LEVEL control **15** selectively accepts trigger and gate signals for the trigger and gate circuits.

19 VCG IN Connector — BNC accepts ac or dc voltages to proportionately control frequency within the range determined by the FREQ MULT **17**. Positive voltages increase the frequency set by the dial **1**; negative voltages decrease the frequency. The VCG IN will not drive the generator frequency beyond the normal limits of a range. Input impedance is 5 kΩ.

20 POWER Pushbutton — Depressed is power on, extended is power off.

3.2 OPERATION

Perform the initial checkout in Section 2 for the feel of the instrument. Any questions concerning individual controls and connectors may be answered in paragraph 3.1.

3.2.1 Signal Termination

Proper signal termination, or loading, of the generator connectors is necessary for its specified operation. For example, the proper termination of the 50Ω OUT connector is shown in figure 3-6. Placing the 50 ohm terminator, or 50 ohm resistance, in parallel with a higher impedance, matches the receiving instrument input impedance to the coax characteristic and generator output impedance, thereby minimizing signal reflection or power loss on the line due to impedance mismatch.

The input and output impedances of the generator connectors are listed below.

Connector	Impedance
FUNC OUT	50Ω
SYNC OUT (TTL)	50Ω
PULSE/SQUARE OUT (TTL)	50Ω
PULSE SYNC OUT (TTL)	50Ω
TRIG IN	10kΩ
VCG IN	5kΩ

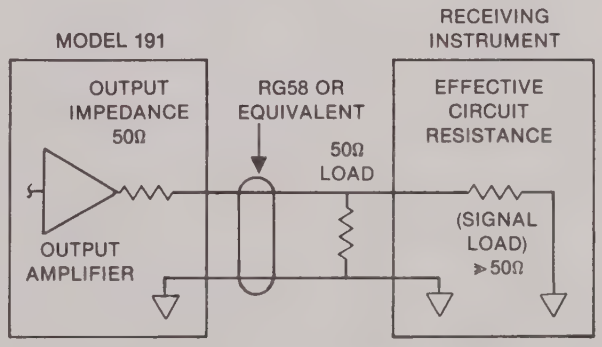


Figure 3-6. Signal Termination

3.2.2 Manual Function Generator Operation

The following steps demonstrate manual control of the function generator. (Bold numbers are keys to figure 3-1.)

Step	Control/Connector		Setting
1	FUNC OUT	**10**	Connect circuit to output (refer to paragraph 3.2.1).

2	MODE	**15**	Select CONT (FUNC).
3	SYM	**3**	Extended.
4	FREQ MULT	**17**	Set to desired range of frequency.
5	Frequency Dial	**1**	Set to desired frequency within the range.
6	FUNCTION	**13**	Set to desired waveform.
7	DC OFFSET	**11, 13**	Set as desired. Limit offset to prevent waveform clipping (see figure 3-3).
8	OUTPUT ATTEN	**8**	Select for desired attenuator range.
9	AMPLITUDE	**9**	Select for desired waveform amplitude.

3.2.3 Voltage Controlled Function Generator Operation

Operation as a voltage controlled function generator (VCG) is as for a manually controlled function generator, only the frequency within particular ranges is additionally controlled by an external voltage (±5V excursions) injected at the VCG IN connector. Perform the steps given in paragraph 3.2.2, only set the frequency dial to determine a reference from which the frequency is to be voltage controlled.

1. For frequency control with positive dc inputs at VCG IN, set the dial for a lower frequency limit.

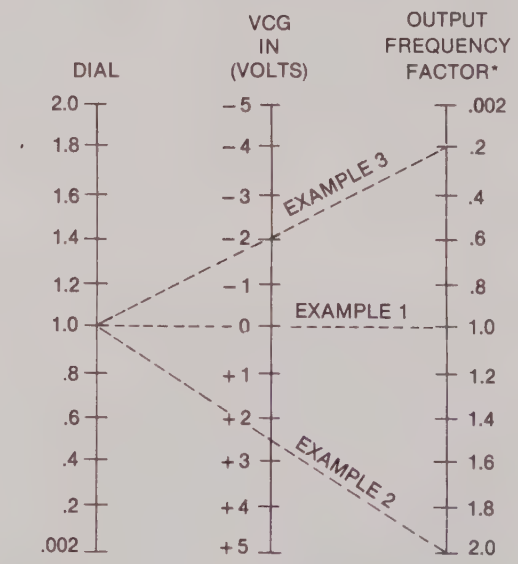
2. For frequency control with negative dc inputs at VCG IN, set the dial for an upper frequency limit.

3. For modulation with an ac input at VCG IN, set the dial at the desired center frequency. Do not exceed the maximum dial range of the selected frequency range.

Figure 3-7 is a nomograph with examples of dial and voltage effects. Example 1 shows that with 0V VCG input, frequency is determined by the main dial setting, 1.0 in this example. Example 2 shows that with a positive VCG input, output frequency is increased. Example 3 shows that with a negative VCG input, output frequency is decreased. (Note that the Output Frequency Factor column value must be multiplied by a frequency range multiplier to give the actual output frequency.)

NOTE

Nonlinear operation may result when the VCG input voltage is excessive; that is, when the attempted generator frequency exceeds the range limits. The upper limit is 2 times the multiplier setting, and the lower limit is 1/1000th of the upper limit.



**Must be multiplied by FREQ MULT switch setting*

Figure 3-7. VCG Voltage-to-Frequency Nomograph

The up to 1000:1 VCG sweep of the generator frequencies available in each range results from a 5V excursion at the VCG IN connector. With the frequency dial set to 2.0, excursions between −5V and 0V at VCG IN provide the up to 1000:1 sweep within the set frequency range.

3.2.4 Waveforms

See figure 3-8 for definition of controllable waveform characteristics.

3.2.5 Pulse Generator Operation

Operation as a pulse generator is similar to the manual and VCG controlled generator except a single pulse, double pulse or square wave may be selected.

The following steps describe the pulse operation setup.

Step	Control/Connector	Setting
1	MODE	**15** CONT (FUNC)
2	Frequency dial	**1** Select pulse repetition rate.
3	FREQUENCY MULTIPLIER	**17** Select pulse repetition rate.
4	FUNCTION	**13** Select PULSE.
5	PULSE/SQUARE OUTPUT	**12** Select desired pulse format.
6	PULSE	**4** Select desired pulse mode.
7	PULSE WIDTH	**6** Select desired pulse width range and approximate portion of range.
8	PULSE DELAY	**2** Select desired pulse delay range and approximate portion of range. (Applicable only if PULSE DLY was selected in step 6.)
9	DC OFFSET	**11, 13** Set as desired. Limit pulse amplitude as necessary to prevent clipping (see figure 3-2).
10	AMPLITUDE	**8, 9** Select desired amplitude.

3.2.6 Burst Generator Operation

In burst mode, the burst generator initiates a gate pulse, controlled by BURST RATE and BURST WIDTH, that gates the main generator. The main generator controls parameters of the signal being burst; i.e., frequency, function and amplitude. Refer to figure 3-8 for burst characteristics.

Set the main generator controls as for manual function generator operation (paragraph 3.2.2) and verify that the output signal is correct (other than not being in a "burst" mode). Then, set the burst controls as follows. (Bold numbers are keys to figure 3-1.)

Step	Control/Connector	Settings
1	MODE/BURST	**15** Select either continuous, triggered or gated burst mode.
2	BURST RATE	**2** Select desired burst repetition rate.
3	BURST WIDTH	**6** Select desired number of cycles in burst length.

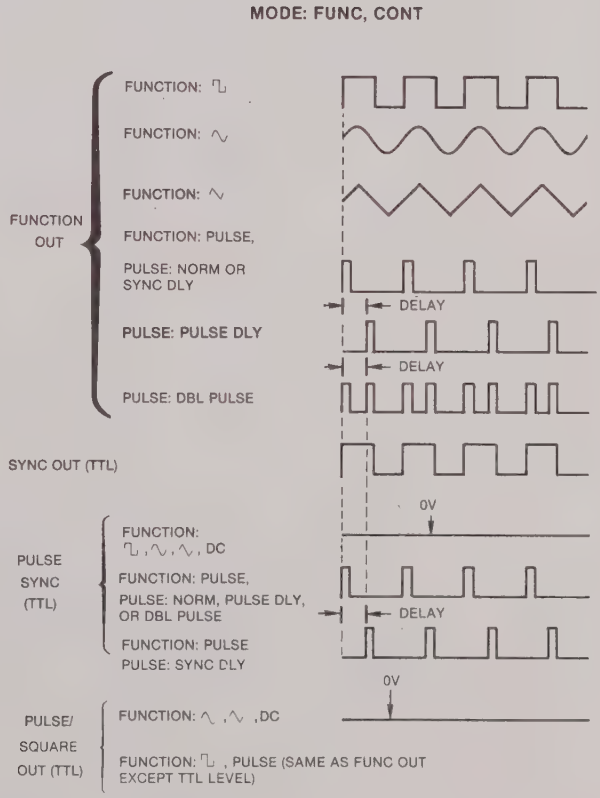


Figure 3-8.Waveform Characteristics

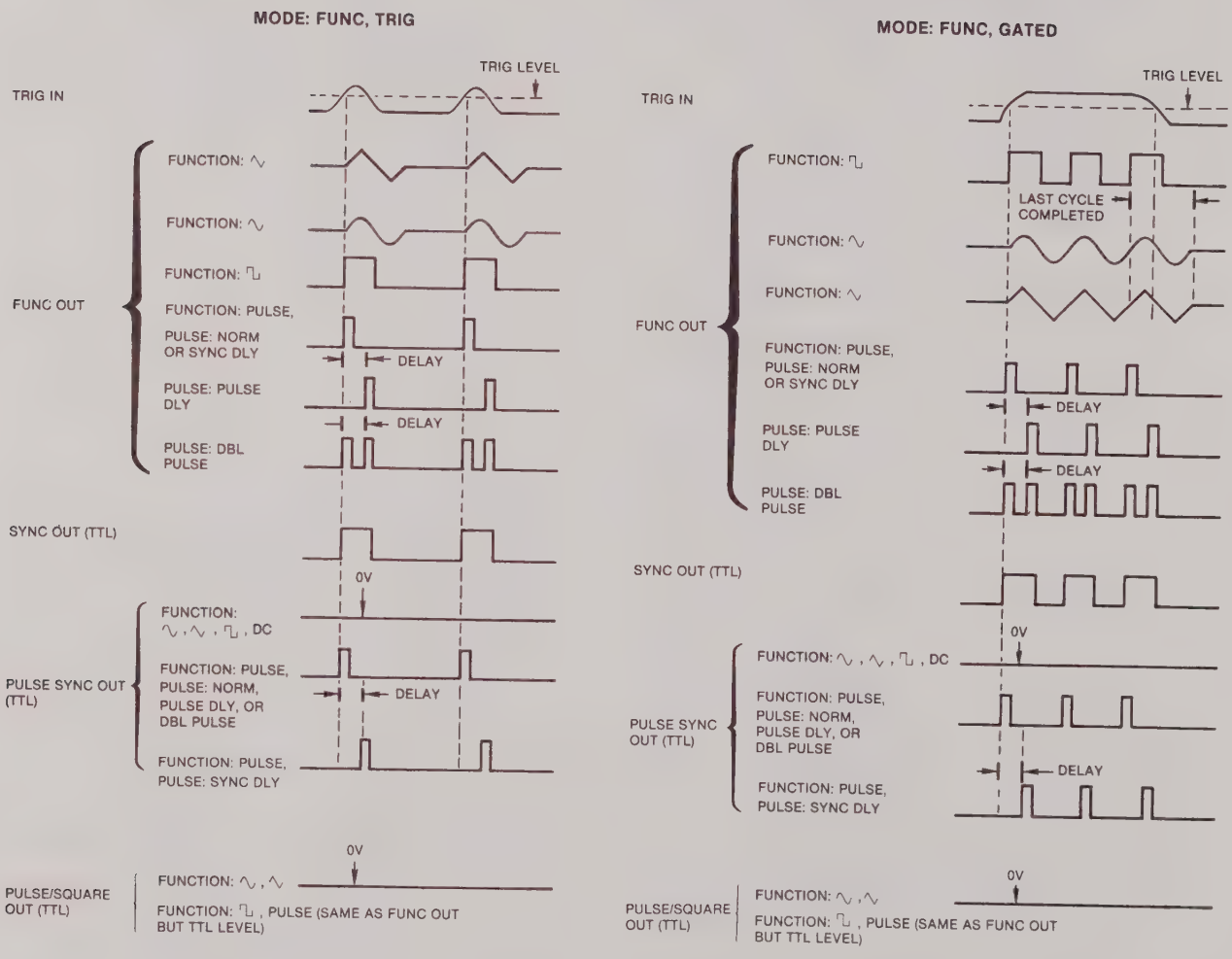


Figure 3-8. Waveform Characteristics (Cont)

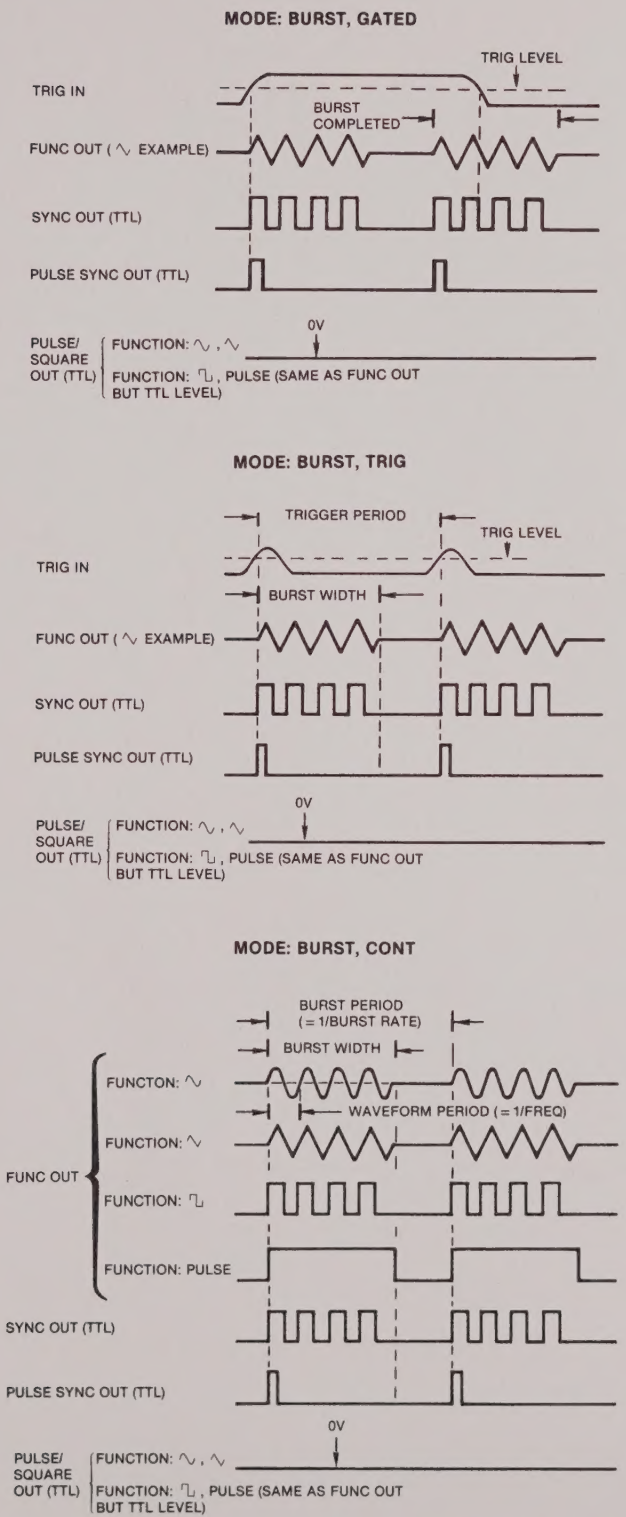


Figure 3-8. Waveform Characteristics (Cont)

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